

CLAIMS

Having thus described our invention what we claim as new
and desire to secure as Letters Patent, is:

254/5004 1 2 3 4 5 6 7
1. A superconductive composition having a transition
temperature greater than 26°K , the composition in-
cluding a rare earth or ~~near~~ rare earth-like ele-
ment, a transition metal element capable of
exhibiting multivalent states and oxygen, and in-
cluding at least one phase that exhibits
superconductivity at temperature ~~in excess~~ of 26°K .

1 2 3 4
2. The composition of claim 1, further including an
alkaline earth element substituted for at least one
atom of said rare earth or rare earth-like element
in said composition.

1 2
3. The composition of claim 2, where said transition
metal is (Cu.)

1 4. The composition of claim 3, where said alkaline earth
2 element is selected from the group consisting of
3 ^{BE}
B, Ca, Ba, and Sr.

1 5. The composition of claim 1, where said transition
2 metal element is selected from the group consisting
3 of Cu, Ni, and Cr.

1 6. The composition of claim 2, where said rare earth
2 or rare earth-like element is selected from the
3 group consisting of La, Nd, and Ce.

1 7. The composition of claim 1, where said phase is
2 crystalline with a perovskite-like structure.

1 8. The composition of claim 2, where said phase is
2 crystalline with a perovskite-like structure.

1 9. The composition of claim 1, where said phase exhibits
2 a layer-like crystalline structure.

1 10. The composition of claim 1, where said phase is a
2 mixed copper oxide phase.

1 11. The composition of claim 1, where said composition
2 is comprised of mixed oxides with alkaline earth
3 doping.

1 12. A superconducting combination, including a
2 superconductive composition having a transition
3 temperature $> 26^{\circ}\text{K}$,

4 means (for) passing a superconducting electrical
5 current through said composition while said compo-
6 sition is at a temperature $> 26^{\circ}\text{K}$, and

7 cooling means for cooling said composition to a
8 superconducting state at a temperature in excess
9 of 26°K .

1 13. The combination of claim 12, where said
2 superconductive composition includes a transition
3 metal oxide.

1 14. The combination of claim 12, where said
2 superconductive composition includes Cu-oxide.

1 15. The combination of claim 12, where said
2 superconductive composition includes a multivalent
3 transition metal, oxygen, and at least one addi-
4 tional element.

1 16. The combination of claim 15, where said transition
2 metal is Cu.

1 17. The combination of claim 15, where said additional
2 element is a rare earth or rare earth-like element.

1 18. The combination of claim 15, where said additional
2 element is an alkaline earth element.

1 19. The combination of claim 12, where said composition
2 includes a perovskite-like superconducting phase.

1 20. The combination of claim 12, where said composition
2 includes a substituted transition metal oxide.

1 21. The combination of claim 20, where said substituted
2 transition metal oxide includes a multivalent
3 transition metal element.

1 22. The combination of claim 20, where said substituted
2 transition metal oxide is an oxide of copper.

1 23. The combination of claim 20, where said substituted
2 transition metal oxide has a layer-like structure.

1 24. A method including the steps of forming a transition
2 metal oxide having a phase therein which exhibits
3 a superconducting state at a critical temperature
4 in excess of 26° K,

B 5 *maintaining*
6 ~~lowering~~ the temperature of said material at ~~least~~ *a temperature less than*
7 ~~to~~ said critical temperature to produce said
superconducting state in said phase, and

8 passing an electrical supercurrent through said
9 transition metal oxide while it is in said super-
10 conducting state.

1 25. The method of claim 24, where said transition metal
2 oxide is comprised of a transition metal capable
3 of exhibiting multivalent states.

1 26. The method of claim 24, where said transition metal
2 oxide is comprised of a Cu oxide.

1 27. A superconducting composition having a transition
2 temperature in excess of 26°K, said composition
3 being a substituted Cu-oxide including a supercon-
4 ducting phase having a structure substantially
5 close to the orthorhombic-tetragonal phase transi-
6 tion of said composition.

1 28. The composition of claim 27, where said substituted
2 Cu-oxide includes a rare earth or rare earth-like
3 element.

1 29. The composition of claim 27, where said substituted
2 Cu-oxide includes an alkaline earth element.

1 30. The composition of claim 29, where said alkaline
2 earth element is atomically large with respect to
3 Cu.

1 31. The composition of claim 27, where said composition
2 has a crystalline structure which enhances
3 electron-phonon interactions to produce
4 superconductivity at a temperature in excess of
5 26°K.

1 32. The composition of claim 31, where said crystalline
2 structure is layer-like, enhancing the number of
3 Jahn-Teller polarons in said ^{composition} composite.

1 33. A superconducting composition having a supercon-
2 ducting onset temperature in excess of 26°K., the
3 composition being comprised of a copper oxide doped
4 with an alkaline earth element where the concen-

5 tration of said alkaline earth element is near to
6 the concentration of said alkaline earth element
7 where the superconducting copper oxide phase in
8 said composition undergoes an orthorhombic to
9 tetragonal structural phase transition.

1 34. A superconducting composition having a supercon-
2 ducting onset temperature in excess of 26°K, the
3 composition being comprised of a mixed copper oxide
4 doped with an element chosen to create Cu³⁺ ions
5 in said composition.

1 35. The composition of claim 34, where said doping el-
2 ement includes an alkaline earth element.

1 36. A combination comprising:

2 a composition having a superconducting onset tem-
3 perature in excess of 26°K, said composition being
4 comprised of a substituted copper oxide exhibiting
5 mixed valence states and at least one other element
6 in its crystalline structure,

B 7 means for passing a superconducting electrical
8 current through said composition while said compo-
9 sition is at a temperature in excess of 26°K, ~~and~~

10 cooling means for cooling said composition to a
11 superconducting state at a temperature in excess
12 of 26°K.

1 37. The combination of claim 36, where said at least
2 one other element is an alkaline earth element.

1 38. The combination of claim 36, where said at least
2 one other element is an element which creates Cu³⁺
3 ions in said composition.

1 39. The composition of claim 36, where said at least
2 one other element is an element chosen to create
3 the presence of both Cu²⁺ and Cu³⁺ ions in said
4 composition.

1 40. A superconductor exhibiting a superconducting onset
2 at a temperature in excess of 26°K, said supercon-
3 ductor being comprised of at least four elements,
4 none of which is itself superconducting.

1 41. The superconductor of claim 40, where said elements
2 include a transition metal and oxygen.

1 42. A superconductor having a superconducting onset
2 temperature greater 26°K, said superconductor being
3 a doped transition metal oxide, where said transi-
4 tion metal is itself non-superconducting.

1 43. The superconductor of claim 42, where said doped
2 transition metal oxide is multivalent in said
3 superconductor.

1 44. The superconductor of claim 42, further including
2 an element which creates a mixed valent state of
3 said transition metal.

1 45. The superconductor of claim 43, where said transi-
2 tion metal is Cu.

B 1 46. A superconductor having a superconducting onset
2 temperature greater than 26°K, said superconductor
3 being an oxide having multivalent oxidation states
4 and including a ^{transition} metal, said oxide having a crys-
5 talline structure which is oxygen deficient.

1 47. The superconductor of claim 46, where said transi-
2 tion metal is Cu.

1 48. A superconductive composition comprised of a tran-
2 sition metal oxide having substitutions therein,
3 the amount of said substitutions being sufficient
4 to produce sufficient electron-phonon interactions
5 in said composition that said composition exhibits
6 a superconducting onset at temperatures greater
7 than 26°K.

1 49. The composition of claim 48, where said transition
2 metal oxide is multivalent in said composition.

1 50. The composition of claim 48, where said transition
2 metal is Cu.

1 51. The composition of claim 48, where said substi-
2 tutions include an alkaline earth element.

1 52. The composition of claim 48, where said substi-
2 tutions include a rare earth or rare earth-like
3 element.

1 (53) A superconductor comprised of a copper oxide having
2 a layer-like crystalline structure and at least one
3 additional element substituted in said crystalline
4 structure, said structure being oxygen deficient
5 and exhibiting a superconducting onset temperature
6 in excess of 26°K.

1 54. The superconductor of claim 53, where said addi-
2 tional element creates a mixed valent state of said
3 copper oxide in said superconductor.

1 55. A combination, comprising:

2 a transition metal oxide having an oxygen defi-
3 ciency, said transition metal being non-
4 superconducting and said oxide having multivalent
5 states,

6 means for passing an electrical superconducting
7 current through said oxide while said oxide is at
B 8 a temperature greater than 26°K, ^{therefore} ~~and~~

9 cooling means for cooling said oxide in a super-
10 conducting state at a temperature greater than
11 26°K.

1 56. The combination of claim 55, where said transition
2 metal is Cu.

1 57. A combination including;
2 a superconducting oxide having a superconducting onset
3 temperature in excess of 26°K and containing at least 3
4 non-superconducting elements,

5 means for passing a supercurrent through said oxide
6 while said oxide is maintained at a temperature greater
7 than 26°K, and

8 means for maintaining said oxide in a superconducting
9 state at a temperature greater than 26°K.

1 58. A combination, comprised of:

2 a copper oxide superconductor including an element which
3 creates a mixed valent state in said oxide, said oxide
4 being crystalline and having a layer-like structure,

5 means for passing a supercurrent through said copper
6 oxide while it is maintained at a temperature greater
7 than 26°K, and

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maintaining
means for ~~cooling~~ *IN* said copper oxide to a superconductive state at a temperature greater than 26°K.

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A combination, comprised of:

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a superconducting ceramic-like material having an onset of superconductivity at a temperature in excess of 26°K.,

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means for passing a supercurrent through said superconducting ceramic-like material while said ceramic-like material is maintained at a temperature in excess of 26°K., and

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maintaining
means for ~~cooling~~ *IN* said superconducting ceramic-like material to a superconductive state at a temperature greater than 26°K.

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A superconductor comprised of a transition metal oxide, and at least one additional element, said superconductor having a distorted crystalline structure characterized by an oxygen deficiency and

5 exhibiting a superconducting onset temperature in
6 excess of 26°K.

1 61. The superconductor of claim 60, where said transi-
2 tion metal is Cu.

1 62. A superconductor comprised of a transition metal
2 oxide and at least one additional element, said
3 superconductor having a distorted crystalline
4 structure characterized by an oxygen excess and
5 exhibiting a superconducting onset temperature in
6 excess of 26°K.

relative to what?

1 63. The superconductor of claim 62, where said transi-
2 tion metal is Cu.

1 64. A combination, comprising:

2 a mixed copper oxide composition having enhanced
3 polaron formation, said composition including an
4 element causing said copper to have a mixed valent

5 state in said composition, said composition further
6 having a distorted octahedral oxygen environment
7 leading to a T_c greater than 26°K .

8 means for providing a supercurrent through said
B 9 composition at temperatures greater than 26°K , and

10 cooling means for cooling said composition to a
11 temperature greater than 26°K .

1 65. A superconducting composition exhibiting
2 superconductivity at temperatures greater than
3 26°K , said composition being a ceramic-like mate-
4 rial in the RE-AE-TM-O system, where RE is a rare
5 earth or near rare earth element, AE is an alkaline
6 earth element, TM is a multivalent transition metal
7 element having at least two valence states in said
8 composition, and O is oxygen, the ratio of the
9 amounts of said transition metal in said two va-
10 lence states being determined by the ratio RE : AE.

1 66. A superconductive composition having a transition
2 temperature greater than 26°K , the composition in-

3 cluding a multivalent transition metal oxide and
4 at least one additional element, said composition
5 having a distorted orthorhombic crystalline struc-
6 ture.

1 67. The composition of claim 66, where said transition
2 metal oxide is a mixed copper oxide.

1 68. The composition of claim 67, where said one addi-
2 tional element is an alkaline earth element.

1 69. A superconductive combination, comprising:

2 a superconducting composition exhibiting a super-
3 conducting transition temperature greater than
4 26°K, said composition being a transition metal
5 oxide having a distorted orthorhombic crystalline
6 structure, and

7 means for passing a superconducting electrical
8 current through said composition while said compo-
9 sition is at a temperature greater than 26°K.

1 70. The combination of claim 69, where said transition
2 metal oxide is a mixed copper oxide.

1 71. The combination of claim 70, where said mixed copper
2 oxide includes an alkaline earth element.

1 72. The combination of claim 71, where said mixed copper
2 oxide further includes a rare earth or rare earth-
3 like element.

1 73. A method for making a superconductor having a
2 superconducting onset temperature $> 26^{\circ}\text{K}$, said
3 method including the steps of:

4 preparing powders of oxygen-containing compounds
5 of a rare earth or rare earth-like element, an
6 alkaline earth element, and copper,

7 mixing said compounds and firing said mixture to
8 create a mixed copper oxide composition including
9 said alkaline earth element and said rare earth or
10 rare earth-like element, and

11 annealing said mixed copper oxide composition at
12 an elevated temperature less than about 950°C in
13 an atmosphere including oxygen to produce a super-
14 conducting composition having a mixed copper oxide
15 phase exhibiting a superconducting onset temper-
16 ature greater than 26°K, said superconducting com-
17 position having a layer-like crystalline structure
18 after said annealing step.

1 74. The method of claim 73, where the amount of oxygen
2 incorporated into said composition is adjusted by
3 said annealing step, the amount of oxygen therein
4 affecting the critical temperature T_c of the
5 superconducting composition.

1 (75.) A method for making a superconductor having a
2 superconducting onset temperature greater than
3 26°K, said superconductor being comprised of a rare
4 earth or rare earth-like element (RE), an alkaline
5 earth element (AE), copper (CU), and oxygen (O) and
6 having the general formula RE-AE-CU-O, said method
7 including the steps of combining said rare earth
8 or rare earth-like element, said alkaline earth

9 element and said copper in the presence of oxygen
10 to produce a mixed copper oxide including said rare
11 earth or rare earth-like element and said alkaline
12 earth element therein, and

13 heating said mixed copper oxide to produce a
14 superconductor having a crystalline layer-like
15 structure and exhibiting a superconducting onset
16 temperature greater than 26°K, the critical tran-
17 sition temperature of said superconductor being
18 dependent on the amount of said alkaline earth el-
19 ement therein.

1 76. The method of claim 75, where said heating step is
2 done in an atmosphere including oxygen.

1 77. A combination, comprising:

2 a mixed copper oxide composition including an
3 alkaline earth element (AE) and a rare earth or
4 rare earth-like element (RE), said composition
5 having a layer-like crystalline structure and
6 multi-valent oxidation states, said composition

7 exhibiting a substantially zero resistance to the
B 8 flow of electrical current therethrough when ^{IN} cooled
B 9 to a superconducting state at a temperature in ex-
10 cess of 26°K, and

11 electrical means for passing an electrical super-
12 current through said composition when said compo-
13 sition exhibits substantially zero resistance at a
14 temperature greater than 26°K.

1 78. The combination of claim 77, where the ratio
2 (AE,RE) : Cu is substantially 1:1.

B 1 79. The combination of claim 77, where the ratio
2 (AE,RE) : Cu is substantially ^{3:1} ~~1:1~~.
N

1 80. The combination of claim 77, where said crystalline
2 structure is perovskite-like.

1 81. The combination of claim 77, where said mixed copper
2 oxide composition has a non-stoichiometric amount
3 of oxygen therein.

1 82. A method for making a superconductor having a
2 superconducting onset temperature greater than 26°,
3 said superconductor being comprised of a rare earth
4 or rare earth-like element (RE), an alkaline earth
5 element (AE), a transition metal element (TM), and
6 oxygen (O) and having the general formula
7 RE-AE-TM-O, said method including the steps of
8 combining said rare earth or rare earth-like ele-
9 ment, said alkaline earth element and said transi-
10 tion metal element in the presence of oxygen to
11 produce a mixed transition metal oxide including
12 said rare earth or rare earth-like element and said
13 alkaline earth element therein, and

14 heating said mixed transition metal oxide to
15 produce a ^{superconductor} ~~superconductor~~ having a crystalline
16 layer-like structure and exhibiting a supercon-
17 ducting onset temperature greater than 26°K, said
18 superconductor having a non-stoichiometric amount
19 of oxygen therein.

1 83. The method of claim 82, where said transition metal
2 is copper.

1 84. A superconducting combination, comprising:

2 a mixed transition metal oxide composition con-
3 taining a non-stoichiometric amount of oxygen
4 therein, a transition metal and at least one addi-
5 tional element, said composition having substan-
6 tially zero resistance to the flow of electricity
B 7 therethrough when cooled to a superconducting state
8 at a temperature greater than 26°K, and

9 electrical means for passing an electrical super-
10 current through said composition when said compo-
11 sition is in said superconducting state at a
12 temperature greater than 26°K.

1 85. The combination of claim 84, where said transition
2 metal is copper.

1 86. A method, comprising the steps of:

2 forming a composition including a transition metal,
3 a rare earth or rare earth-like element, an
4 alkaline earth element, and oxygen, where said
5 composition is a mixed transition metal oxide hav-
6 ing a non-stoichiometric amount of oxygen therein
7 and exhibiting a superconducting state at a tem-
8 perature greater than 26°K,

B 9 ~~cooling~~ ^{maintaining} said composition ^{IN} to said superconducting
10 state at a temperature greater than 26°K, and

11 passing an electrical current through said compo-
12 sition while said composition is in said supercon-
13 ducting state.

1 87. The method of claim 86, where said transition metal
2 is copper.

1 88. A method, including the steps of:

2 forming a composition exhibiting a superconductive
3 state at a temperature in excess of 26°K,

B 4 *maintaining* *at*
~~cooling~~ said composition to a temperature in excess
5 of 26°K at which temperature said composition ex-
6 hibits said superconductive state, and

7 passing an electrical current through said compo-
8 sition while said composition is in said
9 superconductive state.

1 89. The method of claim 88, where said composition is
2 comprised of a metal oxide.

mod
1 90. The metal of claim 88, where said composition is
2 comprised of a transition metal oxide.

*Add B2
+ E1*

*add
2911
Add
K1*